WASHINGTON STATE DEPARTMENT OF ECOLOGY

July 24, 2003
(Updated May 2006)

CONDITIONAL SHORT-TERM USE LEVEL DESIGNATION FOR BASIC (TSS) & ENHANCED TREATMENT & PILOT USE LEVEL DESIGNATION FOR PHOSPHORUS TREATMENT

For

Washington State Department of Transportation's Ecology Embankment

Ecology's Decision:

Based on the performance data obtained at the SR 167 test site and the design criteria submitted by Washington State Department of Transportation (WDSOT) Ecology is hereby issuing the following designations for WSDOT's Ecology Embankment (EE) technology:

1. **A Conditional Short-Term Use Designation for Basic and Enhanced Treatment.**

2. **A Pilot Level Use Designation for Phosphorus Treatment.**

3. **These designations expire on September 30, 2006 unless extended by Ecology, and are subject to the conditions specified below.**

4. **Ecology hereby approves the WSDOT QAPP dated October 2004.**

Ecology's Conditions of Use:

Ecology Embankments shall be designed, installed, and maintained to comply with these conditions:

1. **Each EE facility shall be designed as per Section 6.0 Hydraulic Design in the applicant's petition (see attached pdf file). Functionally equivalent designs may be substituted, but Ecology shall be informed of such substitutions.**

2. **The EE Ecology Mix shall be installed per applicant's specifications in Section 8.0 Ecology Mix (see also Appendix C) in the applicant's petition.**

3. **The EE facility shall be constructed as per Appendix B: Ecology Embankment Details in the applicant's petition, except the soil used in the filter strip application shall be per BMP T5.13, Post Construction Soil Quality and Depth, in Ecology's most recent**

***Stormwater Management Manual for Western Washington,* or other functionally equivalent soil amendments. .**

4. **The approved QAPP must be followed and includes additional testing at the SR 167 and/or another site to achieve the following:**

    a. **To comply with the TAPE's statistical and minimum sample size requirements;**

    b. **To determine the impact of solids accumulation in the Ecology Mix on infiltration rate and design life of the media before replacement and to determine the characteristics of the Ecology Mix at the conclusion of the testing, including the total phosphorus, calcium, zinc, and copper content;**

    c. **To include copper influent and effluent data consistent with the TAPE. If the data collected in the ensuing conditional use timeframe do not indicate or make it difficult to conclude that copper removal rates meeting Ecology's performance goals are occurring, then additional samples, in accordance with the TAPE protocol, will be necessary in order to draw conclusions within the certainty that the TAPE requires.**

    d. **To the extent practicable, evaluate the EE sizing criteria, including the maximum water quality and peak hydraulic flow rates;**

    e. **WSDOT shall add to Section 8 of Appendix C particle size specifications and mixing procedures for the components of the Ecology Mix, including the surface layer.**

5. **WSDOT shall complete all required testing by July 2005, in accordance with an Ecology approved QAPP.**

6. **WSDOT shall submit a TEER for TRC review by August 31, 2006. Include an updated design, operation, and maintenance manual with the TEER.**

7. **WSDOT may request Ecology to grant deadline or expiration date extensions, upon showing cause for such extensions. Lack of funds to complete the monitoring will not be viewed by Ecology as sufficient cause.**

8. **Discharges from the EE shall not cause or contribute to water quality standards violations in receiving waters.**

Applicant:	Washington State Department of Transportation (WSDOT)
Applicant's Address:	Environmental Affairs Office PO Box 47332 Olympia, WA 98504-7332

Application Documents:

- Petition to the Washington State Department of Ecology for Approval of the Ecology Embankment (EE) Best Management Practice (November 2002)

- SR-167 Ecology Embankment Water Quality Monitoring Project Final Report (June 2002), with Appendices A (Storm Event Monitoring), B (Particle size distribution analysis methods by UW), C (SRE and water quality concentration correlation graphs), D (WAC acute and chronic freshwater zinc criteria calculations), and E (Graph of monitoring vault water levels)

Applicant's Use Level Request:

General Level Use Designation for Basic, Enhanced, and Phosphorus Treatment, in accordance with Ecology's 2001 stormwater manual.

Applicant's Performance Claims:

Monitoring results for this project show that the Ecology Embankment system is promising as a highway runoff treatment best management practice (source: SR-167 Final Report, June 2002). The outstanding removal of total suspended solids and dissolved metals meets Ecology's percent removal treatment goals for every event sampled (source: WSDOT personal communication, Ed Molash, email, May 2003).

Technical Review Committee Recommendations:

The Technical Review Committee finds sufficient evidence that WSDOT should be able to demonstrate, through additional laboratory and field testing, that it will attain a General Use Level Designation (GULD) for Basic and Enhanced Treatment levels. The Committee also finds that the EE has merit and should be further investigated for its effectiveness in treating phosphorus.

Findings of Fact:

1. WSDOT is operating an EE system on SR-167 that had been installed in 1996. This system was monitored for 9 storm events in 2001 and 2002. This falls short of the TAPE guideline of at least 12 and up to 35 storms.
2. Aggregate TSS removal efficiency was about 91 plus or minus 3 percent, with individual storms ranging from 69 to 97 percent. This appears to meet Ecology's "80 percent TSS removal on an annual average basis" Basic Treatment goal.
3. Average TSS effluent value was about 12 mg/L, ranging from 4 to 26 mg/L. Average TSS influent value was about 97 mg/L, ranging from 21 to 204 mg/L. This appears to meet Ecology's "attain 20 mg/L effluent TSS for influent TSS below 100 mg/L" Basic Treatment goal.
4. Aggregate total recoverable zinc removal efficiency was about 90 plus or minus 6 percent, with individual storms ranging from 73 to 95 percent. Aggregate dissolved zinc removal

efficiency was about 89 plus or minus 6 percent, with individual storms ranging from 60 to 97 percent. This appears to meet Ecology's "higher removal rate of dissolved metals than basic treatment facilities" Enhanced Treatment goal.

5. Aggregate total phosphorus removal efficiency was about 74 plus or minus 15 percent, with individual storms ranging from 12 to 90 percent. Influent TP concentrations ranged from 0.11 to 0.43 mg/L. Whether this meets Ecology's "50 percent reduction goal for influents ranging from 0.10 to 0.50 mg/L" Total Phosphorus is not determinable.
6. The hydraulic and mass balance of the system was not fully resolved by the study. The portion of runoff accounted for ranged from 13 to 120 percent. Water loss appears to be related to absorption and evaporation from the EE media and infiltration into the road shoulder. This uncertainty leads to the plus or minus ranges specified above for pollutant removal performance.
7. Taylor Associates prepared and followed a QAPP based on an early TAPE draft. Taylor's report does not indicate what would have been done differently had the monitoring been conducted according to the final TAPE QAPP guidelines.
8. The EE is not in general use by WSDOT or other entities in Washington State.

Remaining Issues or Concerns about the EE Technology:

1. Resolve the water budget issue. The main concerns are whether the flow monitoring methods are accurate, and if not, whether stormwater is bypassing to surface water without treatment.
2. Maintenance and replacement. How do pollutant removal efficiency and hydraulic capacity decrease over time, and at what point is maintenance or replacement required? How do maintenance operations (such as mowing or herbicide application) affect performance?
3. The EE is actually a treatment train, consisting of a bioinfiltration/filter strip and a media filter bed. To what extent does each component contribute to contaminant removal, and what are each component's design specifications? What happens if the sheet flows become concentrated, bypass the filter strip, or the filter strip does not work for some other reason? Provide details on the media (such as particle sizes, impurities, and target pollutant removal mechanisms).
4. Determine whether, over its effective life cycle, the facility removes phosphorus and meets the 50% total phosphorus treatment goal, or whether it mainly captures particle phosphorus, converting and releasing it as dissolved phosphorus.
5. Address issues with particle size distribution testing, including the finding of larger PSD in effluent versus influent, the sieving and exclusion of particles above 212 microns, and errors introduced by using sub/partial versus whole samples in PSD testing.
6. If possible, a different EE facility should be tested in the future. The location should be selected to verify slope or soil-related siting limitations. The testing should attempt to carefully monitor water balance.
7. At WSDOT's option, the facility may also be considered for oil treatment, provided adequate data meeting TAPE guidelines are collected.

Technology Description:

The Ecology Embankment is a flow-through water quality treatment device developed for use where available right-of-way is limited and longitudinal gradients are less than 5%. The Ecology Embankment, which can be sited on both highway side slopes and medians, uses infiltration through a pervious, alkalinity-generating media, called the Ecology Mix, that was designed to remove suspended solids and soluble metals from highway runoff through physical straining, ion exchange, carbonate precipitation, and biofiltration. For illustrations, design specifications and maintenance criteria open the following pdf file.

EE_Petition.pdf

Components of the Ecology Embankment:

No Vegetation Zone - The no vegetation zone (NVZ) is a shallow gravel trench located directly adjacent to the highway pavement. The NVZ is a normal highway feature and is not strictly a component of the Ecology Embankment. However, it is an important element of the Ecology Embankment treatment train, in that serves several purposes that assure the Ecology Embankment's optimal performance. These purposes include acting as a level spreader to promote sheet flow and as a sump to collect coarse sediments, reducing runoff volumes through infiltration to subsoils, making mowing easier, and improving driving safety by precluding the buildup of sediments directly adjacent to the paved highway, which can cause ponding during precipitation events. The NVZ should be a minimum of 1 foot and a maximum of 3 feet wide, depending on the availability of lateral space at the site.

Vegetated Filter Strip - The length of the vegetated filter strip (VFS) is dependent on the availability of space within the highway side slope. The baseline design criteria for the VFS within the Ecology Embankment calls for a 3 foot minimum width, but wider filter strips are recommended if the additional space is available. In addition, use of suitable soil amendments within the VFS is recommended to maximize treatment efficiencies.

Ecology Mix Media Bed - The Ecology Mix is a mixture of pea gravel, dolomite, gypsum, and perlite. The pea gravel provides the matrix for the media, the dolomite and gypsum add alkalinity and ion exchange capacity to promote the precipitation and exchange of heavy metals, and the perlite promotes moisture retention to promote the formation of biomass (epilithic periphyton) within the Ecology Mix. The combination of physical filtering, precipitation, ion exchange, and biofiltration provides the water treatment capacity of the mix. The Ecology Mix has an estimated initial infiltration rate of 100 inches per hour, a long-term or ultimate infiltration rate of 25 inches per hour, and a design infiltration rate of 14 inches per hour.

Gravel Underdrain - Within the underdrain, a perforated pipe can be installed for drainage during wet periods in Group C and D soils. In most Group A and B soils, an underdrain is unnecessary, as the water will percolate into subsoils from the underdrain. The underdrain pipe should be a 8" PVC perforated pipe with the holes situated at 30°-45° from vertical using the standard listed in Section 9-05.2(6), *Underdrain Pipe*, of Standard Specifications. The gravel

backfill for the underdrains should conform to Section 9-03.12(4), *Gravel Backfill for Drains*, Standard Specifications.

Contact Information:

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Applicant's Website: http://www.wsdot.wa.gov/environment/eao/wqec/wqec_water.htm

Ecology web link: http://www.ecy.wa.gov/programs/wq/stormwater/newtech/index.html

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